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PLEASANT HOURS WITH THE MICROSCOPE.

BY HENRY J. SLACK, F.G.S., F.R.M.S.

THE figures now given illustrate the descriptions in the last paper, and show some of the principal varieties of infusoria. They will also enable some interesting questions concerning their movements to be considered. Motion that looks more or less like voluntary is by no means confined to the animal world. Motile spores of algæ, for example, are very common, and there are few objects more fascinating than the exquisite emerald-spangled globes of volvox swimming with the aid of numerous cilia. There are no sharp boundaries between the animal and vegetable worlds, but as advances from the lowest forms are examined, a positive preponderance of character is discovered. Speaking generally, the respiration of plants is like that of animals. They absorb oxygen and evolve carbonic acid; but they can also digest that acid, and use its carbon to build up their structures, which thorough animals cannot do. The chlorophyl of plants is the agent for effecting this process, and a few animals which possess it—Euglenæ, for example—may have a similar power. In proportion as organisms exhibit decidedly animal characteristics, we might expect their movements to appear more like the *will*-directed actions of the higher orders, and this is generally true. When moving objects jostle together, go to the edge of a containing cell and stick there, or in any other way appear blundering, they probably belong to the vegetable world. Mr. Saville Kent, whose opinion is entitled to great weight, finds that as a rule the animal types "make tentative, well-controlled progress in various directions, and intelligent deviations." Let us investigate this. Fig. 1 shows a minute creature (*Heteromita lens*) with a small whip; the little group of dots are its spores. The magnification is 800 linear. Many much smaller objects swim skilfully by means of similar whips. In this group and in many others, Mr. Kent observes that the movements seem to be intelligently guided. It is impossible without intolerable circumlocution to speak of these things with accurate precision. In using such a word as intelligence, it does not mean the same as if it were applied to a human being, but something on a lower platform, in some respects resembling it. Fig. 2, *a* and *b*, are *Euglenæ* (*E. viridis*). They were formerly placed by most authors amongst the plants, but Mr. Kent confirms the observations which assign to them a small mouth, and he succeeded in inducing them to swallow minute particles of carmine. On this, and on other accounts, he claims them as animals.

On a sunny day, go to a quiet pond that is covered, or streaked, with a thin scum, like green-pea soup. Skim a little into a bottle, and the capture most likely consists of myriads of beautiful little fish-like things of emerald lustre, with a so-called ruby eye-speck. These are *Euglenæ*. There are several species; the commonest—the one figured—varies from 1-1150″ to 1-240″ in length. The bottle containing them should be kept in the light, to promote their development. In the dark they sink to the bottom; the light brings them to the surface. They are furnished with a remarkably elastic integument, and can assume all sorts of odd shapes, or a globular one. Our object now is to watch their swimming. A drop of the water containing them is placed in a little glass cell, 100th of an inch deep. This gives them plenty of room for moving at different depths. A half-inch objective, with A or B eye-piece and dark-ground illumination, shows them off well. Continual watching rarely detects a collision. For hours together they swim backwards and forwards, this way and that, often with sudden changes of direction as sharp as those of a swallow or bat. If one is comparatively quiet, a little ripple amongst floating particles proclaims the motion of the long, whip-like swimming organ, but the lash itself is invisible, or very troublesome to see with any power while the creature is active; and when it rounds itself, and lies still, it is not displayed. To see it, put a droplet of tincture of iodine, as big as a pin's head, on a glass slide; then add a rather larger droplet of water containing the creatures; put gently over them a thin covering glass. They all die off-hand, and the whips are then so plain that we wonder they were not seen before. They are rather longer than the animal, and their arrested motion leaves them in wavy or twisted patterns. The swimming is sometimes assisted—perhaps entirely caused—by contractions and expansions of the integument; but often the queer changes of shape must make it more difficult for the whip to move the creature, as it does, in a definite way. Fig. 5 is a Paramecium, with plentiful rows of cilia, but its motions are not so wonderful as those effected by the whip of the *Euglena*. Where a cilium is highly magnified, and its motion becomes slow as the water dries up, it is seen to be much like what can be done with a long flexible cane, held in the hand, and worked by sharp turns of the wrist. A wave motion runs from the base to the tip. When an animalcule uses a quantity of these organs, rhythmical agreement is the chief thing necessary; but how to row a canoe with a whip-lash is quite another matter. Whips and cilia are commonly described as the same things, only differing in stiffness. Watching the work of the whips leads the present writer to regard them as very different things. The *Euglena* has its whip at the mouth (red speck end), and it pulls itself forwards through the water, with rapid changes of direction. It is impossible to conceive this could be done by moving the whip by an impulse from its base only, as is the case with cilia. The whole length of the whip appears highly vitalised, while the cilium is only an elastic bristle of a delicate description. A curve at any part must modify the direction of the currents produced by its lashing, and as the motions always look skilful and purposeful,

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each portion must concur with the rest, just as much as the several joints do in a prehensile monkey's tail. Many infusoria have a plurality of whips at their anterior end. Fig. 4, *Amphimonas dispar*, has two; Fig. 3, *Cercomonas acuminata*, has one at each end, and it must want some skill to prevent their motions from conflicting.

Fig. 6 represents *Euplotes patella* in two positions. The under side is exhibited in *a*, and *b* gives a profile view. This creature swims with its cilia, or walks with its bristles. Intelligence, or a sufficient substitute for it, guides the animal to the right use of these two sets of organs, but nothing in the locomotive line done by the ciliata, or heterotricha, is so wonderful as the *Euglena* whip work.

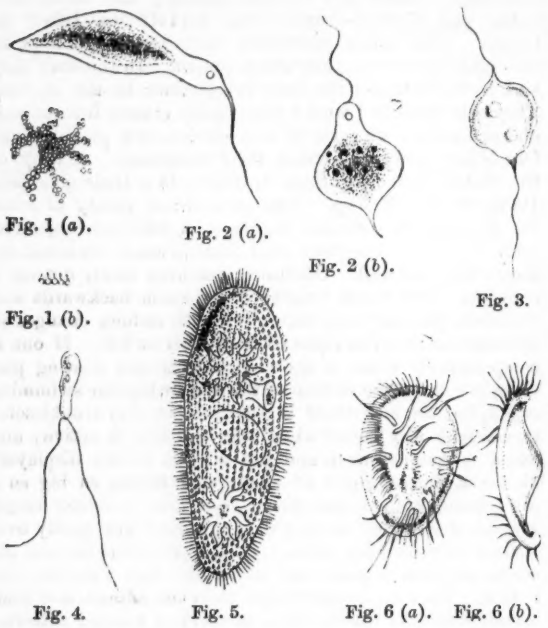

Fig. 1 (*a*). Fig. 2 (*a*). Fig. 2 (*b*). Fig. 3. Fig. 1 (*b*). Fig. 4. Fig. 5. Fig. 6 (*a*). Fig. 6 (*b*).

Fig. 1, *a* and *b*, represents the spores and young of Heteromita lens, × 800. Fig. 2, *a* and *b*, Euglena viridis in two positions, × 250. Fig. 3, Cercomonas acuminata, × 500. Fig. 4, Amphimonas dispar, × 800. Fig. 5, paramecium aurelia, × 75. Fig. 6, Euptotes patella, *a*, under side; *b*, walking attitude, × 140.

When any bird or insect does a skilful-looking thing, it is popularly said to be directed by *instinct*, but few persons endeavour to mean anything really intelligible by the term. Instinct in birds and insects, for example, is not, as often asserted, unerring; it does not compel the creature always to do the same thing. It does not preclude experiment, and, to a certain extent, a modification of plan and use of new materials. Instincts are probably inherited aptitudes, and in their higher exhibition are associated with reason. What are we to say of the lower and of the far minuter objects that perform acts of locomotion, food-seeking, &c., in a way that must be called skilful, and which would be impossible unless their bit of protoplasm had molecules so arranged as to perform work analogous in character to the nerve actions of higher animals? They must receive impulses from without, and send forth the right sort of impulses in reply to them. To avoid an obstacle means taking some physical cognisance of it, and directing the motile organs accordingly. To move after prey with aspect of skill requires some faculty of recognising where it is, of distinguishing it from other things, and of steering accordingly. Do these minute creatures think? No one supposes that they are conscious of their existence; that they reflect upon the sense impulses they receive; or that they knowingly exercise a will force, or have such a feeling as desire; but, after dismissing as improbable the attributes that belong to animals with an elaborate nervous organisation, there is much to be accounted for that differentiates them very strongly from inorganic matter, and that prefigures some, at least, of the mental processes of higher beings.

In investigating the phenomena of living beings we soon feel that we are in the presence of an unknown something which is not like any merely physical or mechanical force.

The iodine solution may be made by dissolving one grain of iodine and three of iodide of potassium in one ounce of distilled water. Half the quantity is an abundant stock for the numerous experiments for which iodine is useful.

CHEMISTRY OF THE CEREALS.

By WILLIAM JAGO, F.C.S.

No. I.

THE name "Cereals" is applied to the group of grasses cultivated for human food; included in their number are wheat, barley, rye, oats, maize, and rice. As a result of analysis we find these bodies to consist in great part of organic compounds, together with a small proportion of inorganic material. This latter, derived from the soil on which the plant has grown, contains potassium phosphate, magnesia, lime, silica, and minute quantities of other ingredients. Our present purpose leads us more especially to the study of the organic constituents of the members of the great grain family; these bodies are themselves of inestimable value to man, and further, by virtue of certain chemical changes, yield a number of other most useful and interesting products. Subjoined is a table giving the average composition of the cereal grains:—

	Wheat.	Barley.	Oats.	Rye.	Maize.	Rice.
Water	11·1	12·0	14·2	14·3	11·5	10·8
Starch	62·3	52·7	56·1	54·9	54·8	78·8
Fat	1·2	2·6	4·6	2·0	4·7	0·1
Cellulose	8·3	11·5	1·0	6·4	14·9	0·2
Gum and Sugar ...	3·8	4·2	5·7	11·3	2·9	1·6
Albuminoids	10·9	13·2	16·0	8·8	8·9	7·2
Mineral matter ...	1·6	2·8	2·2	1·8	1·6	0·9
Loss, &c.	0·8	1·0	0·2	0·5	0·7	0·4
	100·0	100·0	100·0	100·0	100·0	100·0

We see from this table that water is present to a greater or less extent in all, wheat and rice containing the least quantity. The sample of wheat was, however, an old one, and therefore will have got drier by keeping.

We also see that starch is by far the most abundant constituent of these grains; its percentage ranges from 52·7 in barley to 78·8 in rice. The first step, then, in the study of the chemistry of the cereals will be to make ourselves acquainted with the nature and properties of this body. The composition of starch is represented by the formula $C_6H_{10}O_5$. Its general appearance is well known, for, besides being largely used for laundry purposes, we find it occurring in a considerable number of other preparations; thus "violet powder" is, or should be, pure starch, scented with orris root, and the various "cornflours" are simply the starch of maize. Let us take a sample of starch as sold by the chemist and examine it. We have a fine white powder, which, on being pressed between the fingers, produces a peculiar sound, known as "crepitating." An examination under the microscope shows that this powder possesses a very marked struc-

ture; writing with that instrument before me, let me describe the observation I have just made. Having obtained a little potato starch, and, in addition, some arrowroot (also a starch), I placed a drop of water on a clean slide, then the smallest pinch of starch, and, finally, very gently pressed down a cover glass. I then looked at each sample with an eighth objective. Taking the potato starch, it is readily seen to be composed of little granules; some of these are spherical, others, which are older, are shrivelled, and have polygonal outlines; some of the more favourably-situated corpuscles show a series of ring-like markings. This latter peculiarity points to these particles having a concentric structure, somewhat like that of an onion. Viewed by polarised light, with crossed nicols, a black cross is seen in each granule. Looking at the arrowroot, the first point noticed is that the granules are larger, and of a different shaped outline. Their form reminds one of the shape of a mussel-shell, and the ring-like markings start, like those of the shell, from a point near one end; using polarised light, the black cross is again seen distinctly, but its arms are no longer at right angles; the centre of the cross also coincides with the point around which the markings are concentric.

These little starch corpuscles of which we have been writing consist of an outer envelope of starch cellulose, a substance closely allied to starch, and of granulose, or starch proper, which constitutes the interior of the granule. Starch, as far as we know, is not dissolved without change by any known liquid. This is, in fact, exactly what we might expect, because starch possesses an organised structure; when once that is destroyed by solution, it can never be restored by simply driving off the liquid; for though by evaporation we may thus obtain, of certain substances, crystals of perfectly regular shape, it is impossible, without the aid of life, to build up organised structures. Cold water is absolutely without action on starch; but take a small quantity and, having shaken it up with water, gradually heat, the starch swells up and forms a thick paste. By the action of heat, the starch granules are ruptured and the interior granulose dissolves; the addition of a large quantity of water renders the starch almost entirely soluble; the little envelopes, however, remain, and may be filtered off from the solution. It is a matter of uncertainty as to whether this soluble starch is chemically or only mechanically distinct from the insoluble form. Before dealing further with the chemical constitution of starch, it will be well to inquire a little into how starch is obtained from the different substances containing it. If a small quantity of wheat-flour be taken and wrapped in a piece of muslin, and then kneaded between the fingers in a small basin of water, the water becomes milky, and there remains behind, within the muslin, a tough glutinous substance, termed gluten. Of this we shall have to say more a little later. Let now the water stand; it gradually becomes clear, and deposits a white powder at the bottom of the basin. If now the water is poured off, and the powder allowed to stay, a fairly pure sample of starch is thus yielded. In manufacturing starch on the large scale, wheat is first coarsely ground, and then wetted with water; on being allowed to stand for some days, fermentation sets in. The wheat is then transferred to large vats, and additional water added; fermentation goes on apace, and the gluten putrefies, evolving a most offensive odour. Certain acids (acetic and lactic) are formed as a result of fermentation, and these dissolve any remaining gluten. The remaining starch is next thoroughly washed and subsequently dried. During the latter operation the masses of starch shrink and split up into the columnar structure so well known in laundry starch. A considerable quantity of starch is also manufactured from the potato. The principle is much the same: the tubers are first washed, then rasped into a pulp, and washed on a sieve; the water, which runs through milky, from the presence of starch granules, is allowed to stand until it deposits its starch; the sediment is then carefully washed and dried. As the potato contains no gluten, the process of putrefaction necessary with wheat is not required. It was before mentioned that "corn-flour" is the starch of maize; in its preparation the disagreeable method of removing gluten by putrefaction is avoided by using a very dilute solution of soda as a solvent for that compound. The gluten is thus first dissolved out, and the remaining starch is washed and dried. In this manner is yielded a very pure and elegant form of starch. While, as a preparation of starch for food-purposes, corn-flour leaves nothing to be desired, it should never be forgotten that it is, after all, starch, and starch only. That cheapest form of starch, viz., that of the potato, has recently been brought into the food market under the name of "potato fécule;" *fécule*, be it remembered, is simply the French name for starch. A glance at the table given at the head of this paper shows rice to be almost entirely composed of starch. For the great majority of purposes where starch is required as an article of food, there is no better substance to use than rice, either in the form of the whole grain or ground into meal by passing through a small hand-mill. The difference in cost of rice compared with that of these other starch products is well known to every prudent housewife.

GEOLOGY AND AGRICULTURE.

By J. VINCENT ELSDEN, B.Sc. (Lond.), F.C.S.

II.

THE quantity of water carried down by rivers depends also upon the strata over which they flow. Thus the Medina, in the Isle of Wight, is a very narrow stream while in the chalk district, but widens out immediately on reaching the less permeable Eocene beds. Indeed, limestone districts can frequently be traced on a map by the absence of streams and rivers. The Thames affords a striking illustration of this influence of geological structure upon the discharge of rivers. In flowing over Lias clay, it is estimated to discharge 320 cubic feet per minute, but coming to the porous Oolitic strata, its discharge suddenly falls as low as 10 cubic feet per minute.

The quality of the water is also influenced by the composition of the rocks through which the river flows; and considering the large amount of irrigation which is carried on in many agricultural districts, the composition of river water is of the first importance to the farmer. Thus, in Surrey, the water of the Mole is far superior to that of the Wey for irrigation purposes, for the Mole, after traversing the Weald, flows through calcareous strata, and becomes impregnated with fertilizing mineral substances; while the Wey flows almost entirely through barren sandy districts. The water from the Lower Greensand of Surrey is also ill-adapted for irrigation on account of the very small amount of mineral matter dissolved in it; nor is it a matter of any surprise that the Lower Greensand itself should form here so barren a soil, considering the small amount of soluble material which it yields. The water from the Carboniferous limestone of Yorkshire, on the other hand, is known to be extremely useful as a fertilizing agent; while the remarkable excellence of the water-meadows of Gloucestershire is

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attributable to the fact that they are watered by streams from the highly calcareous rocks of the Cotteswolds. Perhaps in no county in England is irrigation less practised than in Warwickshire—a fact which is easily explained by the physical features of the district, for the majority of its streams originate in the elevated plateau around Birmingham, known as the *watershed of England*, and have not yet been long enough in contact with the rocks to have acquired enough dissolved mineral matter to make them valuable as fertilizing agents. Just as a fertile oasis marks the position of a spring of water in the parched and barren desert, so, though in a less degree, is the fertility of our English soils influenced by the peculiar character of the water of each geological formation. The saliferous marls of Staffordshire give rise to such brackish streams, that on their banks sea-side plants are frequently to be found; but the injurious influence on agriculture of an excessive amount of soluble matter in the underlying rocks is best seen in the immense natron plains of Hungary, between Arad and Debriczin, which are rendered unproductive by an efflorescence of soda-salts from the soil; while in some low tracts of land on the shores of the Mediterranean, which are too salt for cultivation, it has been found necessary to remove the saline matter by artificially flooding with fresh water, and afterwards draining.

Perhaps no geological agency exerts so much influence upon agriculture as denudation—that slow and silent action whereby the surface of the earth has been moulded into its present form. Thus the mechanical action of running water acquires an agricultural interest almost as great as its chemical influence, which we have just considered. Not only are immense quantities of the most productive soils carried away by this means, but by being deposited in other localities, the most fertile admixtures are often produced. This accounts for the great improvement which soils usually exhibit near the outcrop of other formations. The peculiar fertility of the hop district of Farnham is due, to a great extent, to the many outcrops, in a small area, of beds of different character, and to the consequent mixing of different soils. The great value of alluvial soils, also, is to be explained by this natural admixture of sediment carried down by running water from strata varying in mineral composition. The Golden valley of Herefordshire owes its superiority to a fertile alluvium derived from the cornstones of the surrounding Old Red Sandstone formation. So valuable, indeed, is the detritus carried down into the sea by rivers, that, in favourable localities, the flood-tide is made, by artificial means, to overflow the fields around and to deposit its precious freight of fertile mud upon the farmer's land. The inundations of the Nile are beneficial to the soils of Egypt only in proportion to the quantity of finely-divided sediment which is thus deposited upon them, and Duponchel has even conceived the idea of fertilising the barren *landes* of Gascony by artificial warping from the Pyrenees. This artificial admixture has been practised with great success in many parts of England, and many a barren soil has been rendered productive by the processes commonly known as claying, marling, and chalking. By judicious admixture of materials from neighbouring strata, many of the waste lands of England have been permanently improved, and have increased in value both to the owner and tenant.

But if advantage is gained by the farmer who cultivates the rich alluvial tracts, the fertility of which may be traced to the nature of, perhaps, distant strata, it is far otherwise with those from whose land the sediment has been transported. In many districts agricultural operations are seriously impeded by the rapidity with which the soil is removed by denudation. This is nowhere so well shown as on steep slopes, such as the sides of the granite hills of Cornwall, or in incoherent soils like the Black Earth of Russia, in which huge ravines are formed with surprising rapidity, and the most fertile alluvium in Europe quickly swept away.

The presence of igneous dykes seems invariably to exert a beneficial influence upon the soil. In some parts of Cornwall, where the general rental of the land is about thirty shillings an acre per annum, the accidental occurrence of an igneous dyke improves the land to such an extent that the produce is nearly doubled, and the rental consequently increased. In a similar way the Carboniferous limestone soils of Derbyshire are greatly improved by the presence of those volcanic rocks which are locally known as *toadstones*, and in some parts of South Wales, where trap-rocks occur, an otherwise barren soil is completely changed and rendered capable of producing nearly every crop. It is interesting to note how quickly the lavas and ashes of Etna are transformed into vineyards or gardens by the ceaseless industry of the husbandmen, even although they are repeatedly destroyed by fresh eruptions.

It generally happens that in those localities where the nature of the rocks has resulted in the production of the most pleasing scenery, there agriculture is least developed. Of course, where the scenery is bold and mountainous, we shall expect to find great hindrances to agricultural operations; but even in districts such as the Isle of Wight or Surrey, we find a pleasing landscape accompanied by a most backward state of agriculture. Nor does it often occur that great agricultural value characterises those districts which are famous for their mineral wealth. The mining districts of England are chiefly noticeable for the general unproductiveness of the soil, which is sometimes so poor that three or four shillings an acre is the utmost rental that can be obtained.

Enough has now been said to show the general connection between agriculture and geology. In the New World, where there is no lack of available ground, colonists need cultivate only the most favourable districts—the alluvial plains and valleys watered by running streams; but the crowded population of Europe necessitates a continual struggle against natural agencies to improve every available spot. Thus by ceaseless toil and industry the greatest obstacles have been overcome. The natural aridity of Egypt, the deficient water-supply of Lombardy and Tuscany, are conquered by the most careful irrigation; wastes have been reclaimed; marshy tracts have been rendered fertile by draining; the hills on the banks of the Moselle and the Rhine and the steep slopes of Provence, in spite of the rapidity with which the soil is washed away, are kept clothed with vines, corn, and olives by the endless toil of terracing the hill-sides, and thus overcoming the obstacles which nature has opposed to successful cultivation.

The Highest Bridge in the World.—This is the railway viaduct of Garabit, in France, now being erected over a river in the department of Cantal. The total length is about 1,880 ft., and near the middle of the great centre arch, the height from the bed of the river to the rail is 413 ft. The viaduct was begun in 1881, and is to be completed next year.

The longest bridge in the world is said to be in China, at Sangang, over an arm of the Chinese Sea. It is five miles long; the roadway is 70 ft. high, and stands upon 300 arches. The parapet is a balustrade, and each of the pillars, which are 75 ft. apart, supports a pedestal on which is placed a lion 21 ft. long, made of one block of marble.

AUSTRALIAN ANTS.

(*Continued from page 374, Vol. III.*)

THE tree-ants are very frequently met with. Of these there would seem to be at least two species, the one contenting themselves with nestling under the loose bark, while the other bore into the trunk of the tree itself, by reason of which habit they are designated carpenters. They do not, however, use timber for building purposes: they only excavate it to provide themselves with a dwelling-place; still, as the particles of wood lie scattered round the root of the tree, looking like heaps of regular sawdust, the designation seems by no means inappropriate. A favourite resort of both these species is dead stumps, and, singular to say, three sides only of the stump are appropriated. These are invariably east, north, and west. These several sides, as every one will remember, are the only ones well exposed to the sunshine, necessary in winter for the comfort of the community, and in spring, summer, and autumn for the hatching of the eggs and the development of the pupæ. A sanitary expert could not have devised his plans more satisfactorily. These ants are very fierce when molested, attacking some of the larger kinds, and often come off conquerors.

The little "sugar ants" are well known to most dwellers in towns, and even in central Melbourne sometimes prove a nuisance to housewives, by invading any saccharine matters that may be left uncovered. They owe their popular name to their fondness for this article of food. If a small heap of the same is placed in their way, they seldom stop to eat it on the spot, but carry the prize away, crystal by crystal, evidently for the benefit of the general population. Fond as they are of sugar, they are still more partial to honey, and will readily leave the former for the latter. This is not carried away, but eaten wherever met with. So attractive seems this ambrosia, that even the queens are tempted out to partake of it. Before depositing the honey I once or twice introduced some stranger ants, who were immediately attacked. While the fight was going on I placed the honey near the belligerents, who, as it seems, having more taste for the pleasures of a terrestrial Valhalla than the turmoil of the battle-field, let go their antagonist to feast with their already nearly gorged *confrères*. On one occasion two combatants fell into the honey. The stranger, owing to superior strength escaped and was followed by a little crowd of his enemies. The object of the pursuers, however, did not seem to be the further punishment of the interloper, but simply to despoil him of the dainty which he was carrying away adhering to his legs and body. If a working ant fell into the honey he was left contemptuously alone to escape as best he could. On two occasions, however, I noticed queens who had similarly come to grief. These, strange to say, were pulled out and cleaned by three or four of the adjacent workers. With respect to queens, there seems to be a good deal of gallantry displayed towards them, altogether independently of nation or race. I have never, in fact, seen a strange queen molested when placed among hundreds of a thoroughly hostile tribe. I once noticed another remarkable fact with respect to the behaviour of ants towards strangers. I had placed some ants fully a quarter of an inch in length upon a board surrounded with water. Soon afterwards I brought home a number of tree ants, together with some twenty or thirty queens and several hundred pupæ, placing my second find at the opposite end of the same board. I fully looked forward for a fight, and so there was, but not as was expected. The tree ants at once began to seize and carry off the pupæ, and in the direction of the stronghold of their gigantic fellow-prisoners. Queens, as before stated, were allowed to pass unmolested, as also, in most instances, were unladen ants, but an ant bearing a pupa or egg in its mandibles was at once assaulted and nipped by some assailant. The pupa was, of course, dropped, the despoiled bearer thereof creeping away badly, sometimes fatally, wounded. Singular to say, the dropped pupa was never appropriated by the attacking party. His object seemed to be murder, to which he was incited for some unknown reason, and not robbery.

Perhaps of all Australian ants the so-called bulldog is the most noticeable. These do not seem to exist at present in any great numbers near Melbourne, although during a walk through the more unfrequented part of woods and paddocks some few are almost certain to be met with in the summer months. Their mandibles are very large, but do not appear to be of the shape especially adapted for wounding the human skin. Their principal means of defence and attack in all probability lies in their formidable sting, a wound from which, although by no means dangerous, is often painful. Their name is most likely derived from the singular habit they have of always facing their enemy bull-dog fashion. It is very rarely that you can make them take to flight. They rather choose to maintain their ground, and assume a threatening attitude. Held captive under a glass, I have frequently seen them attack spiders many times their size, and armed with formidable jaws. The spider, however, is a dangerous adversary, his flight being often attended with mishap to the pursuing party, since the fugitive has a habit of playing a thoroughly Parthian trick during his retreat, not, however, shooting an arrow, but darting out a series of webs, which adhere to, and generally disable, the enemy. Bulldog ants would seem to have some idea of colour, and, like the bovine monarch defending his seraglio, have an especial antipathy to objects of a bright ruddy tint. In confinement, at any rate, I have seen them fairly rush at a piece of scarlet silk, seizing it with apparent fury, and holding thereto for several seconds. Although not very numerous near town, they seem to be holding their own in some remote parts of the colony. According to Mr. Selwyn's geological reports, issued some fifteen years since, a party of his surveyors were literally driven out of a district near Cape Howe by swarms of these pugnacious little animals.

A remarkable kind of ant is sometimes met with near town. It is of a metallic sap-green colour, usually of about five-eighths of an inch in length, rather lively in its motions, but not, by all accounts, given to either bite or sting. Its defence is the singular attitude which it takes up when an alarm is given or an enemy approaches. It suddenly elevates the abdomen so that this stands nearly perpendicular. In this position it may really appear very formidable to some would-be assailants, although man is not likely to be greatly intimidated thereby. This particular ant seems to be especially addicted to solitary habits, and it is on very rare occasions that as many as two are seen together. It would also seem to be of the female sex, which, in this instance, is not formed according to the general rule. On the other hand, the males are capable of flight, are of much smaller size, and very sluggish in their movements. At the proper season a female is often seen followed by some five or six of her male admirers, who, with their slow motion and the rather peculiar arrangement of their wings, remind one of a group of languid swells clad in ulsters, and with well-bred lounge dogging the footsteps of some reigning belle as the latter coquettishly "does the block" on a fine afternoon.—*Australasian.*

XUM

SEA ANEMONES

AT THE FISHERIES EXHIBITION.

A popular account of the principal Sea Anemones in Tank No. 10,* *and the Subsidiary Vases.*

BY THOMAS KIMBER, M.A., Lond.

THIS exhibition of sea anemones as a whole is probably the largest, if not the most varied, collection that has ever been made. Many of the examples here displayed are of extraordinary beauty, much exceeding in size those usually obtained, while in freshness and depth of colour they could not be surpassed, and have rarely been equalled. The very great difficulties invariably attending the setting up of an aquarium appear at length to have been successfully surmounted, and the tanks, if not yet quite bright, are brightening, and are becoming increasingly attractive and more interesting, and daily drawing larger numbers of visitors to inspect and examine them. That the readers of KNOWLEDGE may take an enhanced interest in this very popular department of the Exhibition, it is proposed to give, first, a short introduction, and, afterwards, in separate articles, descriptions of the choicest anemones to be seen in the Exhibition, with sufficient details as to outline, colour, and dimensions, that each may be easily recognised, and also to add a few words on their habits and the localities in which they are generally found.

All living beings are endowed with organs or means of providing for nutrition and reproduction which are absolutely necessary for their existence and continuance. These are called organic functions, because all organic beings possess them; they have, too, been called *vegetable functions*, because in vegetable life these organs alone are found.

Sensation and motion occur in animal life, and are called *animal functions*. This restriction of *two* living functions to plants, and its extension to *four* in animals, draws the line between plants and animals.

It was for a long period held that many of the lower animals which have a manifest resemblance in external form to plants participated in the functions of both. They were supposed to be plants endowed with animal properties, and were hence called *zoöphytes*, that is, animal plants. The name is still retained, though now their true place amongst animals is fully accorded to them. From their likeness or fancied resemblance to our most elegantly fringed and radiated flowers, the names anemone, sunflower, carnation, marigold, were respectively applied to several species by Ellis, a London merchant, who has given a very accurate account of these animals as observed by him a hundred years ago. He has been called the father of English Zoöphytology. Independently of the above popular appellations are the names assigned by naturalists, which are generally derived from Greek or Latin roots, and have reference to the character or structure of the object named. *Actinia* (Gk. ἀκτίν, a ray) is the scientific name of the genus sea anemones.

To economise space, and to make our descriptions more exact, we premise a few definitions.

The parts of an anemone—considered as an animal plant—to be described are:—

1. The root, called the base or foot.
2. The stem, called the column or body.
3. The flower, called the disk or face.

1. The foot (*basis*), by which the animal adheres to rocks or shells.

2. The body (*columna*), may be smooth (*lævis*), warty (*verucosa*), longitudinally furrowed (*sulcata*), transversely furrowed or insected (*insecta*), if the intersections are deep or constricted (*constricta*), if crossed by lines or furrows, *i.e.*, cancellated (*cancellata*), if rough like the bark of a tree or corrugated (*corrugata*). The substance may be leathery (*coriacea*), fleshy (*cornosa*), pulpy (*pulposa*). Warts on the column are often suckers (*acetabula*). At its summit (*vertex*) the column is cut off in a transverse direction, and a margin (*margo*) is formed. In some cases the margin rises and forms a parapet (*tichium*). Between the margin and the feelers or tentacles (*tentacula*) there may be a groove or foss (*fossa*). The margin may be notched (*crenata*), or formed of tentacles, *i.e.*, tentaculated (*tentaculata*).

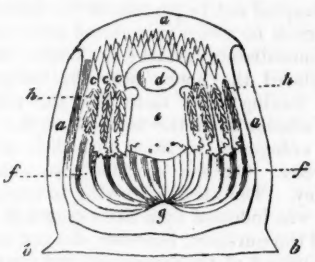
3. The disk (*facies*) is the flat top of the column. It is either plane (*plana*), wavy (*undulata*), lobate or frilled (*sinuosa*). In the centre of the disk is the mouth (*os*), with lips (*labia*). Converging lines on the disk are *radii*. Two radii, strongly marked, on opposite sides of the mouth are gonidal radii (*radii gonidales*). From the surface of the disk spring the tentacles or feelers, which are hollow cones, with a root (*radix*) and a tip (*apex*).

Flower (*anthus*) is the term used to describe the anemone when the disk with its tentacles are expanded.

Button (*oncus*) is employed to explain that the tentacles and disk are retracted or concealed.

Sea anemones are the *Actiniæ* of Baron Cuvier, a genus of the *Acalephæ* (nettles), which again forms his third class of *Zoöphytes*. The internal structure of the anemone has been carefully investigated, to show which we give a vertical section for reference.

THE DAHLIA, *Actinia coriacea*, Cuvier.



a a a. Tegument, *septum.*
b b. Foot by which the animal attaches itself.
c c c. Three rows of tentacles.
d. Mouth.
e. Stomach.
f f. Longitudinal muscles.
g. Point in which they unite.
h h. Ovaries which open into the stomach.

Generally anemones can at pleasure either attach themselves, or creep, or float. The cold weather drives them from the shore to deeper water. On changing their abode, some creep along the bottom, some abandon themselves to the waves, and others, it is stated, turn themselves inside out, and use their feelers as feet. The longitudinal muscles shown in section above conduct to the tentacles placed round the creature's mouth, and are believed to be the tendons which move its feelers at the will of the animal. The actiniæ are incommoded by a strong light, noise startles them, they are affected by odours, and fresh water kills them. They may be cut perpendicularly or crosswise, and each cutting will usually live and become a new animal.

* Another and, perhaps, almost the most attractive branch of the aquaria is that which contains the anemones, for the finest specimens of which the Committee are indebted to the Directors of the Brighton Aquarium, who have given every assistance to procure a thorough and handsome collection.—*Official Catalogue*, page 148.

They also issue already formed from the mouth, and sometimes a portion of the base is severed, continues to live, and in time grows into a complete actinia. Actiniæ feed, in their free, natural condition, upon medusæ and other small crustaceous and molluscous animals, which they seize with their tentacles, and afterwards disgorge what they cannot digest. In aquaria they are fed successfully upon fragments of meat. Many species are eaten as a delicacy in tropical countries, where they are much more numerous than on the British coasts.

MR. LESLIE STEPHEN ON THE INFLUENCE OF SCIENCE.*

"IF it were a qualification for his office," Mr. Stephen remarked, "to be impartial in the sense of not having an opinion on the matter, it would have been hardly possible to select a less qualified chairman in all London than himself. He believed that the spread of scientific influence had not only not been bad, but that the thing of which we stand most in need is a great deal more scientific thought and method in every direction. He felt, however, that his case was so strong that he could afford to give points to the opposite side; and for this reason, and because, to a certain extent, he was prepared to go with the opener in his remarks, he hoped to be able to point out fairly where the various arguments which had been used found their proper place. The only definition, or rather description, of science which ever appeared satisfactory to him was that—Science is that body of truths which may be held to be definitely established, so that no reasonable person doubts them. To speak of mischievous science is, therefore, to assert that truth is mischievous, an assertion to which no one would be likely to seriously agree, especially in such a place as University College. If it is to be supposed that science is mischievous, it must either be meant that certain false theories which call themselves science are wrongful, which may well be the case, or that the scientific progress at the present time happens to be exercising a mischievous influence.

"No one denies that science may accidentally lead to a large number of our particular mischiefs, as in the case of the invention of dynamite; but it cannot in any way be admitted on that account that science is mischievous. For the question arises, if science is bad, what can be substituted for it? and in what way will these mischiefs be remedied if we are not scientific? It is impossible to say that erroneous impressions will make us better off than correct ones. For instance, the old belief in medicine subjected people to years of torture because of supposed witchcraft. In India it is still believed in some parts that smallpox is a demon, and efforts are made to propitiate it, so that, if unnecessary torture and small-pox are evils, we are better for the light which the scientific man has thrown on these subjects. Still it must be admitted that in particular ways the development of science has produced new evils as well as new benefits, and for that matter no sort of progress is made without collateral evils. But the question then remained as to the remedy, and in his opinion that remedy could be very shortly described as more science and not less. There is no sort of conflict between a scientific and a literary education. Everybody ought to have some literary knowledge, and everybody ought to be taught the first principles of science; even a smattering of chemistry might be useful in a literary pursuit. He himself had found what little smattering of science he had acquired at Cambridge and elsewhere of the greatest use in every other kind of study. The habits of thought and feeling acquired by the study even of mathematics, which he took to be the most uninteresting science there is to most individuals, are very useful when one comes to need accurate thinking anywhere, even in matters purely literary.

"It had been urged that science prevents a man from taking the same sort of pleasure in nature as he would do without it. Wordsworth was very fond of saying this, and of denouncing generally the scientific position. But the reason of that was that Wordsworth knew nothing about science. The result was that there is no other instance of so great a poet leaving off writing great poems so early in his career. All his finest poems were written in his early life; and the reason is that he went mooning about the mountains by himself, and did not get any new thoughts. In contrast to him Goethe stands out as a man great in both science and poetry, and is a typical example of the way in which they react on one another. Whenever it was suggested that science is opposed to a love of nature, the speaker always thought of the greatest man of science of modern times, Mr. Darwin, whose books are, apart from their scientific value, quite delightful in their literary style. No one, for instance, could read his "Voyage in the *Beagle*" without seeing that Darwin's love of science was only a part of his love of nature. There is, indeed, no conflict between the two, and a man cannot strengthen the one side of his nature without at the same time contributing to strengthen the other. Indeed, the reason why so many of our living poets are inferior to those who wrote at the beginning of this century, or to those of an earlier generation still, is just that they have not had the pluck to look science in the face, but have only taken a passing and sideway glance at it.

"An important point in the argument—namely, the relation of science to morality—was suggested by the remarks that had been made on the subject of vivisection. The vivisection question, in the first place, did not seem to him to be quite fairly stated. People speak as though vivisection were a recent practice just introduced by a hard-hearted scientific generation. But in point of fact vivisection had been going on for many centuries. The thing which was new was the objection to it. The stock argument in favour of vivisection—that by it the discovery of the circulation of the blood was made—is only one of many instances.

"It had been remarked by a previous speaker, with whom he was inclined to agree, that there had been a great increase in humanity in modern times, and that this increase is to be attributed to the growth of science. It is not true, for instance, to say that the abolition of excessive and cruel punishments has been due to the action of a few energetic but unscientific individuals. They were, on the contrary, put down by the growth of the scientific spirit of the age—a spirit closely allied to humanity, and which showed itself in the philosophy of the eighteenth contury, especially in the writings of Hume and Bentham. They gave up the idea of punishment as simply a revenge to gratify the feelings of the punishers, and took the Utilitarian ground, that it must only be administered in so far as it is beneficial to society. They were thus inevitably drawn into denouncing excessive punishments. Romilly, who

* Remarks by Mr. Leslie Stephen in summing up a debate at University College, London, on the motion by Mr. B. Paul Newman: "That the spread of scientific thought and method has, on the whole, exercised an injurious influence on English society." The motion was supported by Mr. N. Mickleman, and opposed by the Rev. A. Capes Tarbolton and Mr. J. G. Pease.

had been cited by the other side, was probably a pupil of that school; and certainly Bentham and Mill were, who really spread the principles which led to the abolition of excessive punishment. And those principles were only the principles of science applied to morality.

"Though he admired our ancestors of the sixteenth century, he felt bound to admit that they were a brutal lot. An instance of how far we have improved in point of humanity is to be seen in Roderick Random. After having reduced his young, amiable, and beloved hero to very great straits through "dissipation," Smollett makes him go to India to purchase a lot of slaves, whom he sells in America at a large profit. This we should consider brutal and degrading conduct, and the fact that we do so consider it marks the great improvement which has taken place in our morality. It is quite true that it is not merely the growth of science, but the general intellectual development of the country which has put a stop to cruelty; but it is equally true that the growth of science is an integral part of that development, and one that cannot be separated from it. None of these things would have been possible unless the intellect had widened; and science has helped to do this. We may hope for similar good results from the application of science to other things; for example, to politics, where there is little enough of scientific principles at present.

"On the religious question I can only say this," Mr. Stephen remarked in conclusion, "that you have got this plain dilemma to face, which cannot be avoided. In the first place, if any religion, or religious belief, is true, what can the holders of it have to fear from the growth of truth, which you call scientific truth? If these beliefs are destroyed, is it not a conclusive proof that they may be false, or at least contain an element of untruth? The religion may, indeed, have been very useful, although not true, and not qualified to satisfy all the aspirations of a cultivated mind. You may see, when a civilised race comes in contact with a lower race, that the effect of the sudden contact may be to destroy the religion and the rule of life of the inferior race, without putting anything it its place. Evils of that kind have been caused by modern science." It is destroying inevitably many beliefs which people have lived under well and happily. It is undeniable that this causes pain, and that it may be injurious to their morality I shall not attempt to deny. But when I am asked to say that therefore science is injurious, I have to come back to my original proposition—the remedy is more science. The only way out of the difficulty is this: We are here, and we have got to go—forward. And the only way is to apply the test of truth to all our beliefs. This effects a certain amount of pain, as every other kind of progress does; but the only other way is to go on believing what you know to be lies. And, without saying which are true and which are false, I cannot see how any person can wish to do anything else but increase the amount of truth, the only satisfactory cure."

Paper Cross-Ties.—A railway cross-tie has, says *Engineering*, been invented in America, made of paper or any other fibrous substance, such as straw or grass. This is reduced to a pulp, and run out into boards. Sheets or layers of this straw-board are laid one upon the other, cemented and pressed into moulds to form the cross-tie, which is practically fire and water proof, having been manufactured under a temperature of 500 deg. It is claimed that atmospheric changes have no effect upon it, that it can be made as cheaply as a wooden one, and will outlive five. It does not rot, and it deadens sound, which would be an advantage upon elevated railroads.

THE BRUSH DYNAMO-ELECTRIC MACHINE.

(*Concluded*).

In the previous article on the Brush dynamo it was stated that its chief feature is its armature, which, in so far as it consists of a ring of iron, with projecting teeth between the coils, resembles the Pacinotti ring. It has comparisons also with the Gramme ring; but the exceptional feature in it is the method of connecting the coils. In the Gramme, and all the long list of closely-allied machines, each coil of wire is connected to the next succeeding coil. In the Brush, however, no two contiguous coils are so joined, each coil being permanently connected by one of its extremities to the coil opposite it. This arrangement is shown roughly in Fig. 5, where R R is the iron ring, and S the shaft. The free ends of the coils are all connected to the commutator. Fig. 6, a diagram introduced by Prof. Thompson, in his paper before the Society of Arts, will help us materially in comprehending the general principles upon which the generation of the current depends. By referring to Fig. 1 (Knowledge, No. 81) it will be seen that (as pointed out in the article) there are two pairs of brushes, pressing on four commutator rings (Fig. 3), which are represented in Fig. 6 by A A′, B B′. The coils permanently connected are (in Fig. 6) similarly numbered, as 1,1, 2,2, &c. S and N represent the field-magnets, the arrows indicating the direction of the current.

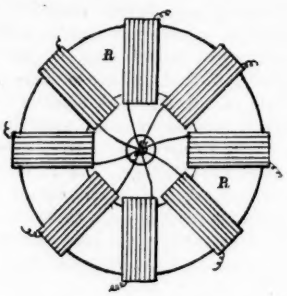
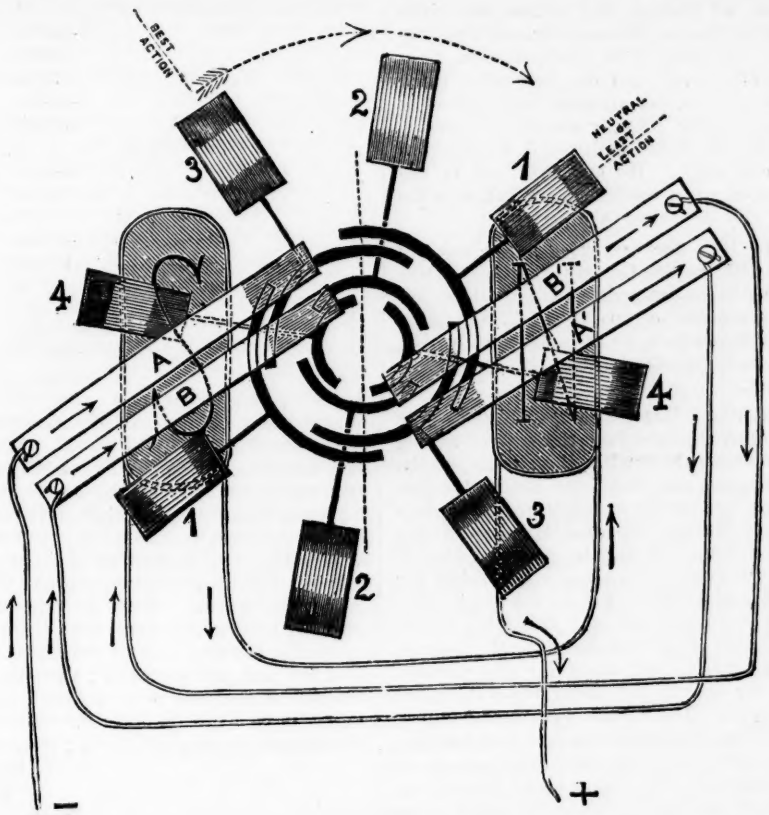


Fig. 5.

As the armature revolves, each pair of coils passes through the magnetic field, and is subjected, successively and oppositely, to every stage of the inductive influence—that is to say (associating ourselves with the coils 1,1), both coils are simultaneously in the neutral zone, or the region of minimum induction, this zone being at right angles to the direction of the lines of magnetic force. In this position, one of the brushes of the commutator presses the insulating piece (C, Fig. 3), and accordingly the circuit through coils 1,1 is disconnected. The object achieved in this arrangement is of a twofold nature. In the first place, the absence of a current in the coils during the period of disconnection allows time for the coils to get cool—an object which is also assisted by the grooved form of the iron ring, currents of air being allowed to pass through these grooves to carry off a large quantity of heat. It must not be forgotten that the resistance of a metallic conductor increases with the temperature, so that there are electrical as well as mechanical objections to a heated machine. In the second place, the coils being in the neutral zone, no useful current is being produced, and if the current produced in the other coils is allowed to pass through them, not only do they perform no good office, but they become a positive obstacle to the production of a

current of the highest efficiency by virtue of the electrical resistance offered by them.

In recently-constructed machines, an insulating block similar to C is fixed on the opposite side of the commutator ring. This addition does not increase the duration of the disconnection, which, as each block, C, measuring one-eighth of the ring's circumference, passes under the brushes twice in each revolution, amounts in the aggregate to 25 per cent. of the time the machine is running. The object attained by the adoption of two insulating blocks is to prevent a "static" charge in the coils, and so to materially reduce the sparking, which in the Brush machine is mainly due to static effects. Reverting to Fig. 6, coils 1, 1 pass next to the positions 4, 4, one going through the north field and the other through the south field. The coils for the current to split at B, part going through 2, 2, and part through 4, 4, reuniting at the brush B'. Thence the current passes through the field magnets in the direction indicated by the arrows, and, exciting them, emerges finally at +, which becomes the positive pole of the machine, the external current being connected to − and +. In Fig. 4 (KNOWLEDGE, No. 81) the current is shown to enter the field magnets after leaving the brush A' and before entering the brush B, in which case B' becomes the positive pole. It is clear that "the four pairs of coils constitute in reality four separate machines, each delivering alternate currents to a commutator, which commutes them to intermittent unidirectional currents in the brushes; and that these independent machines are ingeniously united in pairs by the



thus approach the zone of greatest action, 3, 3, simultaneously, but in opposite phases. Similarly, as they pass the position 2, 2, they both recede from the maximum and approach the minimum zone simultaneously and in opposite phases.

Regarding the armature at a moment when the various coils are in the position indicated in Fig. 6, the coils 3, 3 are in the region of maximum action, one coil being connected to the brush A, which becomes the negative pole of the machine, the other coil at the same time communicating its positive charge to the brush A', and thence by wire to the brush B. The coils 2, 2 have left the position of best action, and the coils 4, 4 are at the same time approaching that position. The induction in each case is only partial, and, accordingly, an arrangement is made device of letting one pair of brushes press against the commutators of two pairs of coils. Further, that these paired machines are then connected in series by bringing a connection round from brush A' to brush B." The Brush dynamo thus involves some of the prettiest ideas hitherto conceived; and multitudinous as has been the number of recently-born rivals, it remains the best where a large number of lamps are required to be worked in series. With the 40-light machine the objection to an electro-motive force of 2,000 volts in the conductors is, of course, a great one. So, also, is the objection to enormous gas-mains, as many living in the region of Tottenham Court-road a year or two since have cause to remember. Where, therefore, such immense currents are employed, it is imperative that the engineering should be

of the best, and that a pennywise policy should never be resorted to. From what has been recently going the rounds, it is to be feared that too little attention is being given to these latter requirements, and that the value of *employés* is estimated more by their servility and energy in "touching their hats to their superiors" than by their capacity for useful and remunerative work.

Overhead Wires in the United States.—Great opposition is being made, especially in Chicago, to the practice of the telephone and telegraph companies of carrying wires close to or over the roofs of houses, without the consent of the owners, or any compensation paid to them. In consequence of several adverse decisions, the companies in some places propose to stop communications.

Consul Berthold, of Breslau, had a free pass given him as a director of the Breslau, Schweidnitz, and Freiburg Railroad. He used it to secure free transportation for a part of the baggage of his wife and daughter when going to Marienbad. For this he was arrested and tried by a criminal court, charged with illegally obtaining a service worth 1·38 dols. He was found guilty, and sentenced to imprisonment for one week. He appealed, but in the higher court, his sentence was confirmed. What, says the *Railroad Gazette*, if this were thus in America?

In Switzerland in 1881 the average distance run per locomotive was 16,039; on the German railroads it was 17,185; and on the Austro-Hungarian roads 16,010 miles. In this country by the last census it was 22,355 miles. Here, therefore, 100 locomotives do as much work as 131 in Germany, 139 in Switzerland, and 140 in Austro-Hungary.—*Engineer.*

How a Locomotive was Raised from a River.—The *Elevated Railroad Journal* relates how the feat of raising a huge freight engine from the mud in Bush River, on the Philadelphia, Wilmington, and Baltimore Railroad, below Havre de Grace, was successfully accomplished a few days ago. The engine fell through the drawbridge some time ago. The difficulties of the feat may be imagined when it is understood that the engine was several feet below the water's surface, and completely buried in the mud. The wreckers have been at work a week, the first thing accomplished being the placing of heavy chains beneath the great mass of iron. Two divers, sent down for the purpose, were compelled to dig several feet under the soft mud at the bottom of the river. The chains were made taut to four heavy scows, which were filled with water at low tide. Everything being satisfactory, the water was pumped out of the scows, thus tightening the chains about the engine. When the tide began to rise, the engine was pulled a few feet from the mud. Then other scows were brought, and when the tide was again low, water was pumped in and the chains fastened to them. The tide went up again, and so did the engine, which came to the surface. After this had been repeated a number of times, the engine was swinging clear of the water, and was then placed on a large float, only slightly damaged, and wanting but few repairs to make it as good as before its tumble into the river. The railroad will now take charge of its fished-up property, and tow it to the river bank near the railroad track. To that point, when the tide is high, a temporary track will be built connecting with the railroad, and when the tide has fallen sufficiently to place the wheels of the engine on a level with the temporary structure, the engine will then be run on the wharf and to the main track. It will be taken to Wilmington and repaired; it cost 1,000 dols. to fish the engine out.

FIGURE CONJURING.

By Richard A Proctor.

THE figure conjurings given by several correspondents seem to me imperfect, because *before* the conjuror has abstracted the numbers really added during his mystifying processes, the number attained shows three out of the four digits in their original order. For instance, in the process on p. 395, the numbers 5, 4, 3, 2 were written down, and the number finally attained by the conjuror's victim is 543,520. I would propose some such arrangement as the following:—Take the four digits in their order, multiply by 2, add 2,460, multiply by 5, add 45, multiply by 10; then subtract (privately) 123,450. Thus, let the numbers be 5, 4, 3, and 2. The process, then, is as follows:—

	5,432
multiply by	2
	10,864
add	2,460
	13,324
multiply by	5
	66,620
add	45
	66,665
multiply by	10
	666,650
subtract	123,450
giving the number	5432|00

Where the trick has to be performed several times the arrangement can easily be varied, especially as regards the sum added at the second step and subtracted at the last. It is convenient to let all the digits of this number be even. Note also that the second digit of the second number added is of no account; it is only added to help the mystification, by avoiding two cyphers at the close of the operations followed by the performer openly. If these rules be followed, the number to be secretly subtracted is always given by halving the three first digits of first addend and appending the first digit of the second. Thus, let the first be 4,280 and the second 37; then the number to be subtracted (or the only part of that number worth considering), will be 2,143 (half of 428 with 3 appended). Take, for instance, the digits 7, 1, 9, 3; then the process will be:—

	7,193
×	2
	14,386
+	4,280
	18,666
×	5
	93,330
+	37
	93,367
×	10
	93,36|70
subtract	2,143
	7,193 as required.

The multiplication by 10, by the way, is quite unnecessary.

Editorial Gossip.

CAPTAIN WEBB is to swim the Lower Rapids of Niagara, for the benefit of himself first—should he survive the experiment—and of the American railway companies in any event. We should be sorry to limit in any way Captain Webb's legitimate right to do what he likes with his own. But unfortunately his plan involves more than this. He is setting a most demoralising example. The railway companies are bartering a life against money, and the rascality of their course is so obvious as to need no comment. But many will feel sympathy with Captain Webb instead of that contempt which should be felt for the man who, being well able to earn an honest living in more ways than one, prefers to stake his life for a sum large enough to keep him for several years, as a reward for a few hours' struggle with death.

IT is time that the nonsense ventilated about Zukertort and his defeat by Sellman and Mortimer should be answered. We are told of the exhaustion following his protracted struggle, of his wilfully giving up the games, and so forth. Any one who plays through the two games will see that Zukertort, having no special reason for wanting to win these two games, was content to play rather for effect than on those strictly sound principles which can alone ensure success in match games. There is not the slightest trace of weakness in his game with Mortimer, the weakest of his opponents; but there is marked evidence of rashness, or rather, of what would have been rashness if success in the tourney had depended on success in this particular game. Men are not apt when exhausted to go in for undue daring.

DR. HASTINGS, finding line 1,474 longer on that side of the corona most exposed, both before and after totality, starts the theory that the outer parts of the corona are merely phenomena of diffraction. The observation really shows that the matter giving this line does not extend into or near the outer parts of the corona. We shall have Mr. Lockyer going back to his first love, the atmospheric glare corona, illustrated by the cork-in-a-shutter experiment, in which the sun is the sun, the cork the moon, and the shutter is—nothing in particular.

THE simple facts that every solar appendage which is not hidden by the moon illuminates our air even at the time of totality, while any illumination so caused must increase with distance from the solar disc, accord perfectly with Dr. Hastings' observation, as with all others yet made, without the absurdity to which he is said to have committed himself,—at which I imagine those among his fellow-workers in America who are competent to form an opinion, as Professors Young, Newcomb, and Langley, will be disposed to smile.

IN KNOWLEDGE for April 6 we chanced to remark of the *Sidereal Messenger* for December, 1882, that it contained chiefly borrowed articles and editorial notes. "'Chiefly borrowed articles!'" says the *Messenger* for June; "KNOWLEDGE ought to know that such a statement is grossly untrue." If we have offended against truth, even this "lie direct" is deserved; and whether it is or not deserved, it shall not provoke the "countercheck quarrelsome." The *Sidereal Messenger*, conducted by Professor W. W. Payne, Director of Carleton College Observatory, is a very useful publication, and of the June number it certainly cannot be said that it contains chiefly borrowed articles. There is an admirable article on the "Effect of Flexure on the Axis of Transit Instruments with the (so-called) Broken Telescope," by Professor C. A. Young, Princeton, N.J.; one article only borrowed (from the proceedings of the Appalachian Club), on "Mountain Observatories," by Prof. E. C. Pickering; an article by the editor on "The Comet of 1882"; one by Mr. Louis Swift on "Intra-Mercurial Planets"; and two other original articles. As to the December number, we do not repeat our statement that it consisted chiefly of borrowed articles and editorial notes, because that would seem like giving our esteemed Transatlantic contemporary the lie direct, and that would not be courteous. We simply note that besides editorial notes and borrowed articles, it contained two original articles, one on "the Computation of a Parabolic Orbit," and one on the "Great Comet of 1882,"—"only these, and nothing more."

WE further expressed our opinion that our own very early discussion of the orbit of the great comet of 1882, in which we expressly referred to the possibility that the Vienna observation of September 24, on which the discussion was practically based, might be incorrect, ought not to have been reprinted in December, when it was known that that observation was utterly incorrect, without some remark to that effect. The editor of the *Messenger*, instead of expressing regret for what was a manifest injustice to us, though doubtless only by inadvertence, dwells now on our unique haste and bold guessing. There was no haste and no bold guessing, but simply what we take to have been an instructive computation (the *Messenger* admits that it involved a simple and neat application of cycloidal geometry), every line of which was correct, and the result, with the proviso indicated plainly in the body of the article, correct also. We repeat now what we said then, that were the observation at Vienna on September 24 correct, the period of the comet would have been as short as we stated.

THE *Spectator* charges Miss Peard, in "Contradictions," with betraying ignorance of cricket, because she describes a player as "caught at slip from a skyer," which he considers next door to an absolute impossibility. Mr. H. Katenkamp, joining issue, says that, on the contrary, of all the fates that await an uncertain batsman, none, especially in the long slip, is more common. To which the *Spectator* makes rejoinder that a "skyer" is a ball hit or driven with the batsman's full force, but with the left shoulder not sufficiently forward; and that "a very late hit to leg might just conceivably send a skyer to the slips." Surely this is absurd. A "skyer" is a ball which flies skywards, whether from a drive, a hit to leg, or a cut. A misjudged late cut at a ball with plenty of spin on is as apt to send a skyer to the slips as any stroke a cricketer can make; but a "skyer" to the slips from a late hit to leg is next to an impossibility, and how such a stroke could be regarded as made with the left shoulder in any degree forward, it would puzzle W. G. himself to imagine. Let any one try to hit a leg ball to the slips with his left shoulder forward, and he will learn that there are twisters other than twisting balls.

THE produce of labour has, we read, been divided between capital and labour as follows in the countries named:—Assuming the produce of labour to be 100 in Great Britain, 56 parts go to the labourer, 21 to capital, and 23 to the Government. In France, 47 parts go to labour, 36 to capital, and 17 to the Government. In the United States, 72 parts go to labour, 23 to capital, and 3 to the Government.

XUM

THE DIVIDED SKIRT.

IN the first number of KNOWLEDGE I gave an amusing article from the *New York Times* about pyramid theories. It was written presumably by Mr. Alden, whose occasional serio-comic articles are a most attractive feature of that leading New York paper. I suppose we owe to the same clever pen an article recently quoted in the *Standard* about a habit chaffingly attributed to the Missourian belles, who, according to this view, might be described as snapping turtle[dove]s. (Four Missourian ladies happened to be present in my house when that article appeared, but observation has hitherto failed to confirm the statements of the *New York Times* in their case, and I can only assume that the habit of biting is not universal among the fair Missourians.) I think readers of KNOWLEDGE will read with amusement the following specimen of Mr. Alden's quaint humour:—

"Mr. Richard A. Proctor, the distinguished astronomer, has recently made some new investigations as to certain heavenly bodies which show him to be a man of great fearlessness and originality.

"According to Mr. Proctor's own statement, set forth in a letter addressed to the London *Times*, he has of late ceased his explanations of the milky way and concentrated all his powers of observation upon corsets and skirts. Of course, his scientific attainments have given him exceptional facilities for exploration in his new field. Knowing the diameter of any given skirt, he is able to calculate its contents, and if the elements of a corset are given to him he can ascertain to the millionth part of an inch the length of arm required to encircle it, and the cubic feet of girl which it contains. Conversely, with a knowledge of the radius of any given girl, he can find the size of both the skirt and corset best adapted to her. There is no haphazard guesswork in Mr. Proctor's investigations of feminine dress. He proceeds by strictly scientific methods, and he grasps figures with an assurance and success which no unscientific person could hope to rival.

"Several interesting experiments have been made by Mr. Proctor upon 'subjects' styled by him the 'ladies of my family.' These experiments began with the removal of corsets. It was found that great advantages at once followed this measure. For example, the voice 'increased markedly both in power and compass,' so that when Mrs. Proctor now remarks to Mr. Proctor, from the top of the stairs at midnight, 'Richard, you've been sitting up with those horrid stars again,' she can be heard by neighbours living at a distance of an eighth of a mile, whereas her voice could formerly be heard only half that distance.

"At the same time Mr. Proctor found that the withdrawal of corsets left the skirts of the subjects insufficiently supported. He therefore substituted 'divided skirts' for those of the usual pattern, and thus obviated the difficulty. With the 'divided skirt,' lawn-tennis, tricycling, and other open-air exercises became much easier, and Mr. Proctor is so completely satisfied with the result which he has attained that he is now longing to deprive all his countrywomen of corsets and to put them into the 'divided skirt.'

"From the tone of his letter, it is plain that the astronomer is more enthusiastic as to the clothing of the women of England than he has even been as to the stars. The transit of a young lady clothed in a 'divided' skirt over a stone wall is watched by him with as much interest as if he were observing a transit of Venus across the sun, and the orbit of a tricycle rider with a divided skirt presents elements more interesting than those of the orbit of any comet. In all probability Mr. Proctor will henceforth throw aside his telescope, and devote himself exclusively to observations made through an opera-glass.

"It may be quite possible that all the advantages claimed for the 'divided skirt' by Mr. Proctor may exist, but whether they would compensate for the ugliness of the garment is a question which most women, and all men with minds uncontaminated by astronomy, will unhesitatingly answer in the negative" [only as no eye, not even the keenest astronomical eye, armed with a telescope of "ten million gas magnifying power" can recognise any change at all, this particular objection scarcely counts.—R. P.].

SOMETHING ABOUT THE BEET.

AS the editor kindly allowed me to put before the readers of KNOWLEDGE a few facts ascertained by chemists with respect to the potato, I am in this going to try if I cannot give some interesting, and at the same time scientific, facts with reference to the beet. In 1880 alone, there were no less than *forty-three* important communications to the scientific world, announcing the results of various investigations carried on in connection with this plant. And it is through this that I think it a duty for some person or other to lay before the public some, at least, of the interesting and useful parts of their (the chemists') investigations. What do most of us know about the beet, beyond the fact that we plant it in our gardens, and in due time eat it, either as pickle or plainly boiled, or prepared like cucumber, or used for salads? I take it for granted that we all, at the same time, know all about the manufacture of this plant for sugar, also its history, and how chemistry in those early days came to the rescue of the manufacturer, so that he might be able to manufacture a sugar in his own country (Germany and France), instead of importing the colonial cane-sugar; how the duties were raised on foreign sugars to make it prohibitory to import them, as it raised the price to a fabulous sum per pound, I forget now how much, and should not like to guess, for fear of underrating the amount; but these and other interesting matters will be found in the "Chemistry of Common Life," by Johnson and Church, by those who have not read the account of it. But it is not my intention to go back to the old ground, but to bring forward later information.

In my communication about potatoes, I showed you what an influence light had on the sprouting of tubers; we shall now see that light has also a very marked effect on beet. Beet, when grown in the shade, runs more to seed, and does not ripen as soon as when it is grown in the open; and to make this more clear, I will give two results obtained by two different chemists to bear out the assertion.

In one case the relation—in the shade—between the leaves and root was 66·34, and in the open the relations were nearly exactly reversed, viz., 35·66. The same chemist found that 1,000 plants in the open yielded 32·5 kilos sugar, while the same number in the shade only yielded 13·4 kilos (a kilo = about 2 lb. 3 oz.).

The other chemist planted a lot of willows, and between the willows he planted his beets with the following results:—The beets he grew in the open yielded 11·14 per cent. of sugar, 350 grammes of root to 100 of leaf, and the beet grown amongst the willows yielded only 8·8 per cent. of sugar, and only 40·3 grammes of root to 100 of leaf (a gramme is not quite 15½ grains).

This shows us how important it is to set our plants in the open, and the same also applies to the potato, for the two plants are very similar in their wants, as we shall see.

We now come to the effect of heat on the growing beet, and we find that a mean temperature of from 14° to 18° C., from May to October inclusive, and a warm and wet spring, together with a not too dry summer, are the best conditions under which beet can be grown. Heat has the same beneficial effect on the beet as on the potato. Beets require a total temperature of 117° C. before they make their appearance above ground, and as beets require to reach perfection in as short a time as possible for successful extraction of the sugar, it is easily seen that too early planting is disadvantageous to the growth and manufacture. Beet thrives best in those countries where a hot summer is followed by a very cold winter (⅘ of the number of degrees Centigrade + 32 = the degrees Fahrenheit, *i.e.*, English temperature). When you cut open a beet you see two concentric rings, the one white and opaque, the other clear, transparent, and mostly coloured; the former contains the chief part of the sugar, while the latter contains the albumen.

Ploughing has a very favourable influence on the quantity of the crop, if the ploughing is deep, and is next in importance to planting,

which we shall see is one of the chief causes of success in beet cultivation. If the manures are ploughed in, the roots form regularly, only about 35 per cent. having irregularities, side roots, &c., whereas in the other case, *i.e.*, if the manure is not ploughed in, the percentage is about 60 per cent.

In thick sowing, the produce of the beet crop is smaller in quantity, but of higher value, on account of the sugar, and in the density and purity of the juice, than in thin sowing. According to the space allotted to each plant, the yield of sugar varied, in one case, from 86 to 91 per cent., and in another case from 88 to 93 per cent. This important fact is more to be considered than the manuring or the kind of beet grown. The distance between the plants should be small on a humid and matured land, but great on a dry, high ground and poor soil.

A better produce is obtained from a sandy soil than from a peat soil. Experiments give for the former 10·46 and 13·90 per cent. of sugar, and for the latter 8·35 and 8·39 per cent. as the yield.

The leaves of the beet have had a good deal of attention given them by the chemist.

Cows fed on the leaves of beet yield more milk a day than when pasture fed, though the milk is lower in total solids and fat; but not only is the yield of milk more through the use of the leaf, but the food is, at the same time, more nourishing to the animal. I will give you one of the results of experiments made to confirm this:—

	Kilos.
After feeding on leaves, weight	485
Before " " "	450
Increase.....	35 kilos.

So we see that there was a gain of at least 82 lb. through feeding the animal with this food.

It is not, at the same time, advisable to feed them entirely on this. The leaves should be preserved in pits, according to the well-known plan, and covered with earth about a foot deep; then, when required for use, given with a mixed diet, containing a large amount of the leaves. It will be found that this is the best kind of fattening fodder for sheep and cattle. The leaves of the beet contain small quantities of glucose, and those roots which have well developed their leaves are the richest in sugar.

The fresh leaves contain about 4 per cent. of oxalic acid, about a third of which exists in a soluble form. It will now be seen why I said it was not advisable to feed cattle entirely on the fresh leaves, as the acid induces inflammation of the mucous membrane of the stomach. Pickling the leaves with chalk will, in all probability, prevent this, as the soluble acid would be converted into calcium oxalate, which is insoluble in the stomach. Leaves of the beet change through keeping; in fact, no other cattle food loses so much by storing as these leaves. The mineral constituents suffer the most, especially potash-magnesia. Phosphoric and silicic acid and chlorine—the soluble oxalates—are also removed, for they are reduced from 1·44 to ·55 per cent. This shows why it is of so much advantage to preserve the leaves, and accounts for the well-known fact that beet leaves are comparatively harmless after having been allowed to decay. Aconite may be extracted from beet leaves, as well as other organic substances.

The residue left by the diffused method of extracting the juice is of much greater value for cattle fodder than that obtained by the hydraulic or maceration processes. We now come to a matter on which some chemists differ—I mean in the relation of phosphoric acid in root and leaves to the sugar in beet. I will give three different results deduced by separate chemists, and leave your readers to judge for themselves if there is, or is not, a relation between the two. These are the results:—

1. There is a certain constancy in the proportion existing between the amount of sugar in beet and the amount of phosphoric acid in the root and leaves, and between the sugar and the ash. Experiments gave the proportion of the former 100 : 1·2 and 100 : 1·15; and the proportion between sugar in beet and ash (root and leaves), 100 : 18·3.

2. Gave for the proportion 100 : 1·15, and says that the relation is constant. It will be seen that his results coincide with Number 1. The higher the yield of sugar the less the soil is impoverished, we are informed.

3. Made experiments to prove that there is a relation between the potash absorbed in the root to the sugar produced. He says this is constant; viz.—about 100 : 2; but he could not observe any constant relation between the phosphoric acid and the sugar.

After seeing these three reports, we see that there is some doubt about the matter, which will, we hope, soon be cleared up. It certainly looks as if there was a certain constant relation, when two chemists, working separately, coincide in their results; but we cannot be satisfied until every doubt is removed.

(To be continued.)

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

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LARGE SUN-SPOT.

[866]—Once more, and for the fourth time within the last eight months, there is a spot on the sun so large as to be visible to the unaided eye.

In observing the sun with my telescope on Wednesday and Thursday last, I saw, besides many other smaller ones, one very pretty group of fair-sized spots. After Thursday, I had not an opportunity of observing the sun with the telescope until yesterday, and I then found that in the meantime one of the spots of this group had grown into a very large one, and on procuring a piece of ordinary smoked glass to look through, I could see the spot distinctly with unaided eyes, it being situated a little north of the sun's centre, and I have again seen it in the same way this morning.

Seen in the telescope, it is a remarkably pretty spot, the central black part, or umbra, being oblong in shape and crossed in several directions by the white streaks called bridges. Just to the east of this spot, and apparently almost touching it, is another good-sized one, very long and narrow in shape; and in close proximity to these two are several much smaller ones, altogether forming a very pretty group. And then, in addition to all these, there are many other small ones scattered about the sun's face, principally near the western edge, so that just now the sun is a pretty sight to any one possessing the means of scrutinising it. EXCELSIOR.

Huddersfield, *July* 2, 1883.

ANSWER TO GENEALOGICAL PUZZLE IN OUR LAST.

[867]—X marries M, and has a son, A. His wife dies (say in 1820), and, in 1822, he marries again, N; and has a son, Tom. X dies in 1824, and his widow, N, marries Z, and they have a son, B.

Or—

M ∞ X ∞ N ∞ Z
| | |
A Tom B

865, page 13. Solution:—

A's father dies.
A's mother marries again, and Tom is born.
A's mother dies.
Tom is brother to A.
Tom's father marries again, and B is born.
Tom is brother to B.
A and B are in no consanguinous way related.

[There are several ways in which the puzzle may be solved. Query, How many?—R. P.]

RATIONAL DRESS FOR MEN.

[868]—I think "Mr. G. C. Mesnard," in writing in favour of braces over the belt, may not know how the belt should be made or worn. I have worn my belt for six years. It was made for me by my tailor, Mr. Davies, of South Molton-street, Bond-street; it is ¾ in. wide, *made of morocco leather*, has a *ring over each hip*, and a special buckle. The rings and buckles in my case are silver, as I could not get the buckle otherwise. It should be worn as low over

the bowels as possible, and kept there by means of loops. This is essential to comfort.

An old sinner I once knew, who had kept his figure well, wore a wide linen belt inside his trousers, fastened at the hips. For heavy trousers I wear a wide belt (material unknown) fastened at the hips and buckled behind. I think "A Woman" will find that trousers are cooler than knickerbockers, as socks can be worn; they also protect the ankles, and prevent dirt getting into the shoes. After much trial I do all manual labour in knickerbockers, but far prefer trousers for walking in. Still, I think knickerbockers would be far more comfortable for ladies; there is a sense of freedom in them. JOHN ALEX. OLLARD, Enfield.

DRESS REFORM.

[869]—Having read most of the letters and articles on "Dress Reform" appearing in KNOWLEDGE, might I inquire, if sufficiently relevant to the subject, of some of our readers who know what the reason or advantage is in wearing the "scarf" round the waist, as worn by Frenchmen, Spaniards, Italians, &c., some of which scarves are very large (1 ft. broad by 12 ft. long)? If this is necessary as part of their dress, it certainly seems ungainly (as 3 or 4 inches of trousers), though it may be rational. FAJA.

[870]—I am sorry I did not describe the divided skirt: there has been so much said about it, that I imagined this was unnecessary. It takes from 4 to 4½ yards of ordinary skirting, and is in two legs, like a large pair of woman's drawers. For any one of medium height, the dimensions of the skirt proper would be as follow:—Entire length (front) 31 in., (back) 1 yd.; length of leg on inside seam 24 in.; circumference of leg at ankle 22 in., at widest part, 35 in. Each leg is trimmed with two kiltings; the little one round the bottom is 2 in. in depth, the other 11 in.

The top of the skirt is gathered into an inch band, one yard long; this band has button-holes in it, corresponding to buttons on the belt. The belt is the most difficult thing to describe, and I doubt if I can do it intelligibly. It fits the hip closely; the depth in front is 7 in., at the back (where it fastens) it is 4½. The foundation is of some stiff material, and has four gores in front. These are 3 in. wide at the top and 4½ at the bottom, but I am very small over the hips. A dressmaker would fit the belt best. The buttons I have mentioned can be anywhere on the belt, mine are round the middle.

I would recommend ladies living in the country not to have the skirt too long, as it catches the mud.

These measurements are carefully taken from a pattern sent me by the original society. I shall be glad to give anyone more particulars if these are not sufficient. PEDESTRIENNE.

ALTERATION IN COAST-LINE, &c.

[871]—Professor Geikie was my authority for saying the sea was gaining on the land on some parts of the east coast of England at the rate of about three feet a century; but I did not say in my letter (768) that the Sheppey cliffs were going at this rate.

From personal observations, I knew the action on the island was very rapid; in fact, I should say it was much greater than your correspondent (820) states.

As regards the submerged forest, my information was obtained some considerable time since from a scientific magazine, the name of which I forget; but I am quite willing to believe Mr. Shrubsole—who is an authority—that after all it was drift timber which had been discovered, and which led to the notion that a "submerged forest" had been found. H'SETT.

THE BELUGA IN THE BRIGHTON AQUARIUM.

[872]—A noble quadruped galloping through the water. Perhaps I ought to have written to Mr. Lockyer about galloping, but should much prefer your judgment, if obtainable.

The first sentence appears to me a correct description of the swimming movement of the dolphin, and at the same time a new view of the motion, or one that has not previously been remarked upon.

Professor Flower has shown (which I learned through KNOWLEDGE) that whales are derived from land quadrupeds, and this being admitted, it follows that their (the whales') progressive movements through the water are derived in the same way.

THOMAS KIMBER.

[It is singular that when I was watching the bottle-nosed dolphin at the Brighton Aquarium, from above (Mr. Lawler kindly accompanied me, and gave me much interesting information), the same idea occurred to me, as I observed the singular contrast between his way of using his tail and that in which a fish uses his. That movement of the tail and the resulting change in the position of the body—which one sees also in the movement of porpoises—is strongly suggestive of galloping, though, of course, the absence of hind legs somewhat impairs the idea.—R. P.]

TO SEE THE SURFACE OF THE EYES.

[873]—Having read the papers and letters on the eyes with much interest, I herewith give a method of seeing the surface of the eye which may be new and interesting.

Make a very small pin-hole through a piece of paper, and, holding the paper about an inch from the eye, look through at a light. If the hole is small enough the sun will do, but gas or candle-light gives the best results. A small spherical or other body which gives a very small but strong reflection will give the same results. I have had several "fires" on my eyeballs, and have found by this method that the marks have remained for a year or two, although they disappeared in two or three days to all outward appearance.

W. MELVILLE.

LETTERS RECEIVED AND SHORT ANSWERS.

G. M. Many thanks. Mr. Clodd's earlier books (sold by tens of thousands) published by Macmillan. But I think the book you refer to, "Jesus of Nazareth," is published by Chatto & Windus. Being away from home (see lecture advertisements) cannot refer to my copy to see. Signalling at whist is playing an unnecessarily high card to a trick, as "five" when you hold "two;" the fall of the lower card in the next round completes the signal.—C. W. HARDING. Do not keep account of such matters. Writers send me their names and addresses in guarantee of good faith, but my memory does not retain them all.—E. H. STUTTER. The word *Times*, No. 87, p. 384, was written without any apostrophe at all, the apostrophe being added by the printers of the *Newcastle Weekly Chronicle*. I meant it as written, just as one might speak of a *Punch* article, or an *Echo* remark. One would certainly not speak of the *Times'* views, but of the *Times's* views; but as you say, where the "es" at the end of a word is sounded, then — and then only — the apostrophe alone should be used, as Moses' laws, Archimedes' theory, and so forth.—P. A. FOTHERGILL. Have not time to look up Mr. Hampden's remarks on evolution; but I agree with you that his being astray on one subject is no reason why he should be astray on all.—E. LUXMORE. Thanks.—J. B. If I missed the first of your questions, it must be in not noticing that what you want me really to determine is the proper meaning of the word "level." I substituted the word "horizontal," in that sense in which it is equivalent to the word "level." If you want to know whether water poured on a perfectly plane table, a mile square and with its plane at the centre at right angles to the direction of gravity, would be deeper in the centre than at the sides, my answer tells you. If you ask whether such a table could *properly* be called "level," I answer "no." If you ask what would be meant by a level table a mile square, I answer that I don't know. Neither the scientific sense of the word "level," nor the ordinary sense, can properly be applied to a surface so large, whether plane or curved. In levelling, distances so short are dealt with that the curvature of the earth may be neglected; if distances much larger are dealt with, other words must be used.—J. S., S. S. L. If you want an exact answer, mine is correct. If you think "the curvature is practically *nil*," then you can leave it out of account. I'm sure I don't want to consider it. As a matter of fact, when a cannon ball is fired with a horizontal velocity of 2,000 feet per second, from a parapet 16 feet high, over smooth water, it travels (apart from atmospheric resistance) 2,000 feet before it has been drawn 16 feet earthwards; and since a point on its original course, but 2,000 feet from its starting-place, is 16 feet 1¼ inch above the water, the cannon-ball is still 1¼ inches above the water at the end of a second, when the one let fall from the same height has just reached the water. So much if you ask for information; but if your object in asking the question was eventually to remind me of the law that "change of motion is in the direction of the impressed force, and proportional to it," I can only say I am very much obliged to you: as I should be if you reminded me of one of the details of the multiplication table.—E. G. McG. Thanks; but quite unable to spare space for such notices.—L. McCAUL. I thank you warmly for the pains you have taken; but the subject is not one to be dealt with so fully in these columns. There are many who are offended at the very use of the word "faith" in that connection, just as they are offended by a common use of the word "loyalty" in a sense which seems to them at once degraded and degrading. I would not needlessly offend these, even if I did not agree with them. The question amounts for most to little more than this: a certain people (not too warmly beloved by

all) seem to have collected everything written by men of their race, as of superhuman excellence, and many outside the race accept that view; others do not: with the former such matters as your father dealt with are very properly regarded as "of faith"; with others they are not so regarded at all. These last take little interest in inquiries of the sort. It seems *to them* the merest accident that instead of them, such matters as the proper interpretation of the Homeric records have not come to be questions of faith. We must consider these, who are many—even among those who are supposed to view matters otherwise.—A. ANDREWS. I am sorry, but it is contrary to "our" rules to answer queries of the sort.—H. ASKEW. Any proof by which it is shown that the sum of the roots of an equation of the nth degree is equal to *minus* the co-efficient of x^{n-1}, will serve to show that the sum of the nth roots of unity, and the sum of their reciprocals, are each equal to zero.—H. C. JONES. Your society for correcting, detecting, and, where necessary, exposing slander, has my heartiest good wishes; but my time is so fully occupied that my joining it would be useless. Many thanks for your kind words and good wishes.—W. T. SOUTHWARD. "Most men" and "a large majority of your fellow-countrymen!" We question each point; but the two statements are very different. Albeit KNOWLEDGE is meant for those who take an interest in science, "Most men" and "the large majority of our fellow-countrymen" do not take the least interest in science. More are students of science now than were so twenty years ago; but they are not one in a hundred of the population yet. Can you imagine that in catering for these, I am likely to consider those others, even if most of them do hold, as you say they do, the ideas you mention? The only way in which those ideas can ever become matter of scientific inquiry is in the way in which they have been touched on here. Their origin, the way in which they have spread, have become modified, have died out among those who inquire, and so forth—these are matters of scientific interest, because, among the subjects of inquiry which science takes up, all relating to man and his ways must be included. If you regard as sneering every expression implying views which do not happen to agree with your particular views, it is unfortunate; but the fault is not here. Of myself personally I may say (so far as I can judge myself), what I recognise as true of Messrs. Slack, Williams, Clodd, Grant Allen, Wilson, and others whose personality comes most clearly before the readers of KNOWLEDGE, that we are one and all exceptionally free from any concern or trouble of mind because others may not view matters precisely as we do. For instance, it appears you differ from me in some points on which you have touched. Very well. What can it matter? If what I say does not commend itself to you, it does *not*, and there an end. No sneer whatever is intended when I say that, while preferring my own views, I have no wish to controvert yours.—H. MALIM. No: the velocity in the original horizontal direction is affected by gravity, which only acts at right angles to that part of the motion at the beginning. See analytical solution.—E. P. TOY. I am much obliged to you; but travel about so much that fear the book might not be returned in due time. May I be permitted to mention here that your letter gives strong avouchment of the truth of the account of Mrs. Croad's thought-reading powers?—P. PERCIVAL. The statement has never, I believe, been challenged. It was discussed a few years ago before the Astronomical Society, but not questioned. Dr. Warren de la Rue brought it, if I remember rightly, before the notice of the society. But while, so far as I know, no one doubts or denies the occasional existence of organic matter in meteorites, what *has* been challenged and thoroughly controverted is the statement made a year or two ago, that the remains of lower types of vegetable and even animal life had been detected in meteorites.—C. J. B. Your question cannot be answered; the velocity of the foot varies from 0 through a maximum to 0, the average rate being 2 yds. (the actual distance covered by the moving foot in a so-called one-yard step) in 44-45ths of a second, the time during which one foot is moving and the other at rest.—A WEAK ONE. So hard to get space; but soon.—G. M. Mr. Clodd's "Jesus of Nazareth" is published by Messrs. Kegan Paul & Co.—G. G. HARDINGHAM. It would not be very easy to answer your questions about star-drift in convenient space here. Maps showing the star-drift for all the stars whose proper motion has been determined appear in my "Universe of the Stars."

SUB-EDITORIAL.

J. S. W.—A. F. O.—J. HARRINGTON.—M. N. E.—A BLIND ONE.—T. J. R.—PERPLEXED.—F. MACKAY. The Editor is not a medical man, nor am I.

ERRATA.—In the solution at pp. 10, 11, the following errata occur: P. 10, line 19 from bottom, for $\frac{1}{2}bc.abC$, read $\frac{1}{2}bc.bC$; p. 11, line 11, for "twice" read "half."

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

BY RICHARD A. PROCTOR.

PART VII.

THE result obtained at p. 15, fitly introduces us to an important class of problems—viz., those in which we have to show that certain lines, areas, &c., are the greatest or least which can be constructed under certain assigned conditions. There are few problems of this sort in Euclid. In fact, the seventh and eighth propositions of the third book are the only theorems in Euclid expressly dealing with geometrical maxima and minima. But many interesting deductions involve such relations as we are speaking of, and it is well for the student to know how to deal with them.

It will be noticed that some of the problems already dealt with may be presented as examples of geometrical maxima and minima. For instance, Ex. 4 may be presented in the following form:—

Ex. 9.—*From a point within a quadrilateral lines are drawn to the angles of the quadrilateral; show that the sum of these lines will be a minimum when the point is at the intersection of the diagonals.*

Presented in this form the problem would be solved precisely as Ex. 4. But suppose it had been given in the following form:—

Determine a point within a quadrilateral such that the sum of the lines from the point to the angles of the quadrilateral shall be a minimum.

Here assuming the student to have no knowledge of the property established in Ex. 4, the problem is not quite so simple. Let us see how it is to be dealt with.

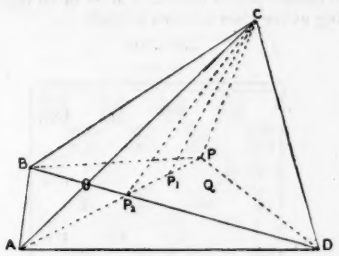


Fig. 14.

Draw first the quadrilateral, A B C D (Fig. 14), and from some assumed point, P, draw P A, P B, P C, and P D. Then we have to inquire how to shift P so as to lessen the sum of the distances, P A, P B, P C, P D.

A very short inquiry suffices to show that we shall not gain much information by considering the lines P A, P B, P C, and P D in adjacent pairs. The inquiry might run somewhat in this way:—If P be brought towards B A, the sum of the lines P B, P A will diminish; but the sum of the lines P C and P D will increase. We have no obvious signs showing whether the diminution or increase be the greater. Therefore we are not tempted to continue this mode of inquiry.

Can we, then, by taking the lines in alternate pairs, diminish the sum of one pair without increasing the sum of the other? By bringing P towards the line B D (which we draw, at this point of the inquiry), the sum of the lines B P, P D, is diminished (Euc. I., 21). Now if this were done without any attention to the lines P C, P A—for instance, if P moved to Q—it would not be easy to assert that the sum of the *four* distances from the angles was diminishing. But if P be made to move along P A, as to P_1, then—since C P is less than P C and P P_1 together—we are diminishing, not merely the sum of the distances from B and D, but the sum of those from C and A. So long, then, as we continue this process, we cannot be going wrong. So that if we bring P to P_2—the intersection of P A and B D—we have diminished the sum of the distances as much as *this* process allows us to do. It is now obvious that by shifting our point from P_2 towards A C, along the line P_2 B, we are yet farther diminishing the sum of the distances, *until* we reach the intersection of P_2 B and A C (which are here drawn in). At this point of intersection, O, the second process has done all it can do for us. We see, also, that O is a fixed point within the quadrilateral, since it is the intersection of the diagonals. Also, P being *any* point, our process shows that wherever our point be taken, the sum of the distances diminishes continually as the point

is made—by the double process above described—to approach O. Thus we are quite certain that O is the required point. Instead, however, of proving this by going through the necessary steps of the above process—which *would* be a sufficient proof—the student should give the proof in the following form, obviously suggested by the process he had before followed :—

Draw the diagonals A C, B D meeting in O; then O is the required point. For, let P be any other point, and therefore not on *both* diagonals—say not on B D. Then B P and P D are greater than B D (Euc. I., 20), and A P and P C are not less than A C (greater than A C if P do not lie in A C); hence P A, P B, P C, and P D are together greater than O A, O B, O C, and O D together.

We have given the process determining the solution, in the form which would most probably suggest itself. The double process is also very instructive and suggestive. But the practised geometrician would probably notice at once that the approach of P towards O, *in a straight line*, diminishes at once the sum of P B, P D, and that of P A, P C. Hence we would argue—in presenting the proof—O *must* be the point we seek; for, let any other point give a minimum sum, then, by taking a point nearer O, we obtain a less sum—that is, said point does *not* give a minimum: which is absurd.

(To be continued.)

Our Chess Column.

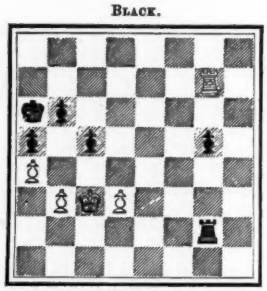
By Mephisto.

USEFUL END GAME.

In a game between Blackburne and English in the late tournament, the former player effected a draw in an ingenious manner, although being at the time a Pawn behind.

English.

Black.



White.

Blackburne.

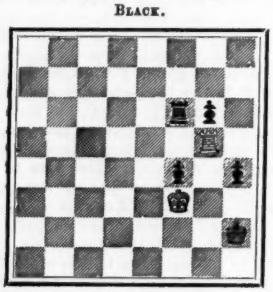
In this position Blackburne drew by playing

K to B4	R to B7 (ch)
K to Q5 (If Black checks on Kt4, White also plays K to Q5)	R to B6
K to B6	R takes QP

R to Kt8, and Black could not avoid the draw, for if K to R2 the R checks on Kt7 and Kt8.

The ingenious idea of placing the K on B6 and threatening a mate or a perpetual check with the Rook, led us to arrive at the following position when playing an actual game :—

Black.



White.

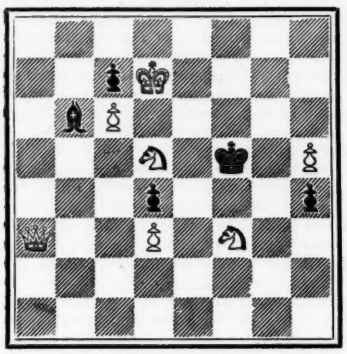
White to play and draw.

It will be seen that we were trying to get a position which might give us a similar chance for a draw, and in spite of the fact of our opponent having three good pawns, we think a draw can be forced. We hope the preceding example will enable our readers to work out this very interesting position. We shall give our analysis next week.

PROBLEM No. 88.

By A. J. Maas.

Black.



White.

White to play and mate in three moves.

REVIEW.

Chess Blossoms.

Miss F. F. Beechy, an experienced problem composer, has published a collection of her two-move problems. These compositions are of more than average merit, as proved by the fact of several of them having won prizes. The prize problems of English problem competitions for 1882 are appended, together with some readable (chessy) verses and poetry. This is a pleasant little book and is published by the authoress at Matlock, Bath.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

R. V. Tyley.—Drawn games are sometimes counted half to each player.

W. Terrill.—Could you kindly send a copy?

G. W. Thompson.—If P moves there is no mate.

W.—Solutions of Ending and Problems No. 86 and 87 correct.

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